Bioenergy and Biobased Products U.S. Departments of Agriculture and Energy Programs

Background Materials

Strategic Partnerships Meeting

hosted by the

DOE National Bioenergy Center

at National Renewable Energy Laboratory

Colorado, April 11-12, 2001

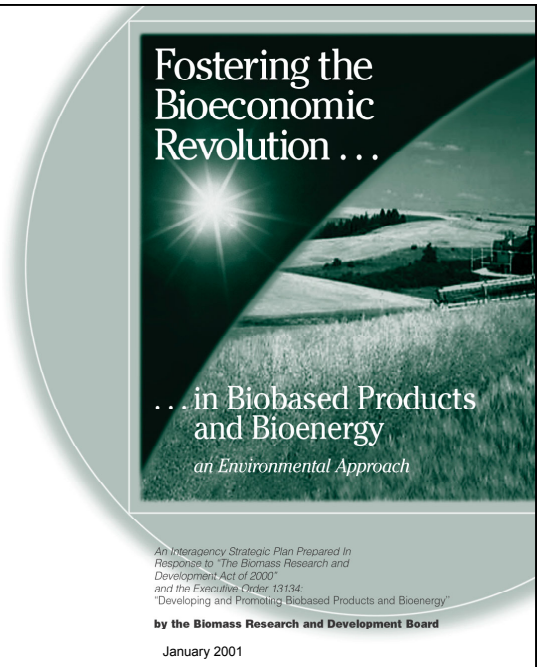
Some Reading Materials

- http://www.bioproducts-bioenergy.gov/
  - Biomass R&D Board Activities
  - Board Strategic Plan
  - Biomass R&D Technical Advisory Committee
  - Publications - Report to the President
  - Biomass Research and Development Act of 2000

Biomass Research and Development Board
Co-chairs
USDA
DOE

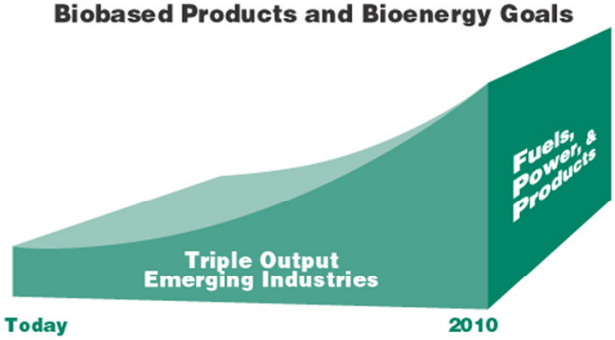
Member Agencies
NSF
EPA
DOI
OSTP

Participating Agencies
DOC
FEE
OMB
Treasury
TVA



See: http://www.bioproducts-bioenergy.gov

Biobased Products and Bioenergy Goals



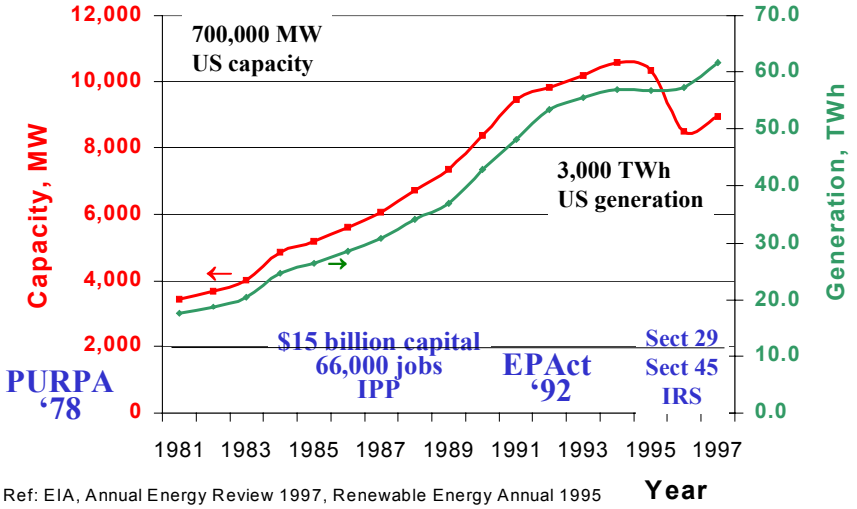
Current baseline for emerging industries:
- ethanol, 1.5 billion gallons
- biodiesel, 6 million gallons
- electricity, 60 billion kWh (from 10 thousand megawatts of capacity)
- emerging products, 10-15 billion pounds (5 - 7.5 million tons).

Figure 1. Biobased Products and Bioenergy Goals: Consistent with federal resource conservation and environmental policies, triple output of emerging industries in fuels, power, and products and facilitate an increase in efficiency of use in mature industries, with special attention to application of new and emerging technologies. (Note: triple refers to specific fuels, power, and products output or any combination)

Baseline

Bi kWh=TWh

Bioenergy Electricity Generation, 1981 - 1997

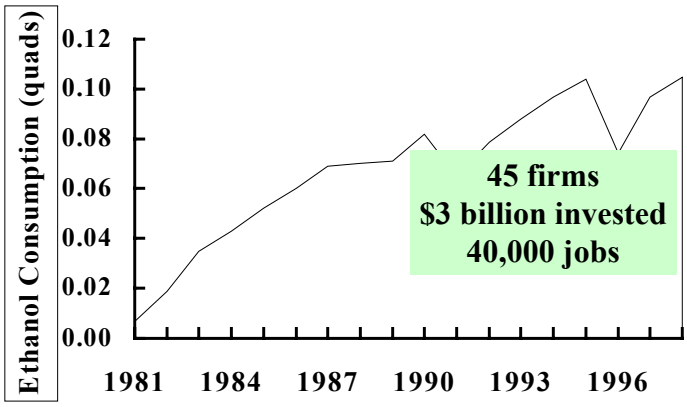


Ref: EIA, Annual Energy Review 1997, Renewable Energy Annual 1995

Portugal: 9,000 MW; 39 TWh; UK: 69,700 MW; 343 TWh

NREL

Baseline
Historical Ethanol Consumption



1.5 billion gallons or equivalent to 1% of gasoline with ethanol from cornstarch

~$750 million/yr excise tax exemption '99

Replace MTBE?

2000 installed capacity about 2.25 billion gallons

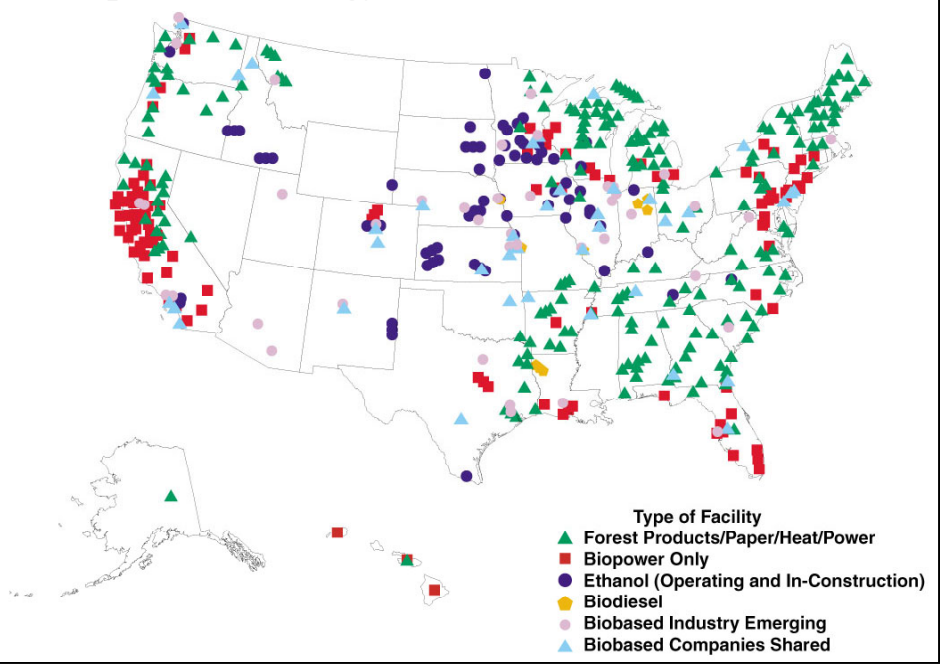
Ref: Energy Information Administration, http://www.eia.doe.gov/pub/energy.overview/aer98/txt/aer1003.txt

Ethanol in Brazil 2-3 times U.S. volume

TABLE 1 Biobased Products Categories and Examples

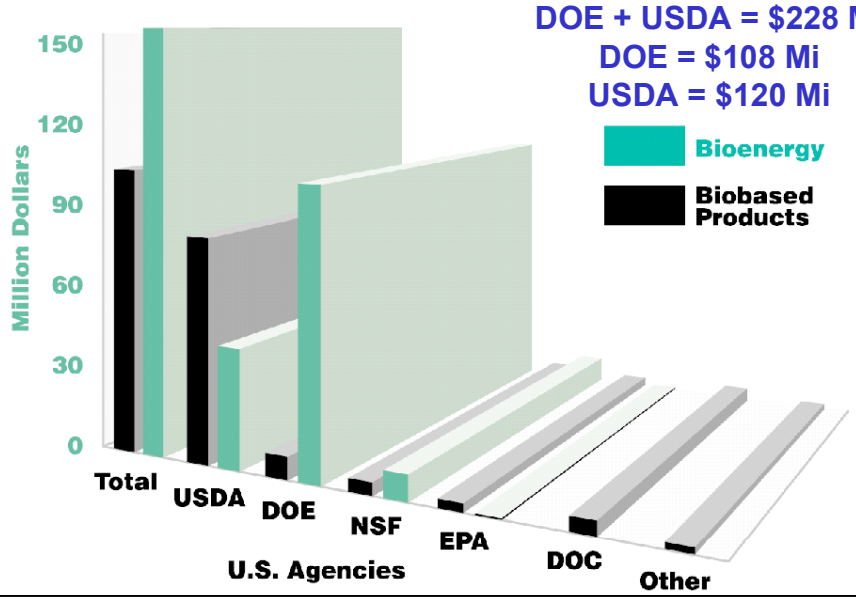
Number	Product Category	Examples of Biobased Products
	Established Biobased Industry	
1	Paper and packaging	Writing papers, newsprint, magazines, and packaging cartons
2	Wood-based composite materials and structures	Lumber, plywood, flooring, furniture, laminates, engineered wall systems, wood/polymer and structural composites, and lignin-based polymers
	Emerging Biobased Industry	
3	Plant-based plastics and polymers and films	Polylactide plastic, starch biodegradable polymers, spider silk polymers
4	Lubricants and functional fluids products	Biodegradable soybean oil-derived lubricants, used grease-refined products
5	Inks	Soybean-derived inks
6	Enzymes	Cellulase for orange juice clarification and stone-washed jeans, amylase for corn industry, enzymes for nutrition enhancement, novel property enzymes
7	Renewable alternative fiber papers and packaging	Kenaf, milkweed, and other agriculture products used for fibers, packaging, and products
	Shared by Biobased Companies and other Manufacturing Industries	
8	Absorbents, adsorbents, and masonry and road materials	Odor control, spill absorbents, animal bedding, pet litter, biocement support, roofing, insulation, road oil, and asphalt
9	Adhesives and bonding products	Sealants, glues for building products, glues for envelopes, wall paper adhesives, soy-based adhesives, marine glues
10	Biocontrol products	Soil amendments, such as topsoil, aggregate, and enrichment, fertilizer and pesticide carriers
11	Solvents, chemical intermediates, and cleaning agents	Methyltetrahydrofuran from levulinic acid, methanol from sythesis gas, cleaners, conditioners, and surfactants
12	Coatings and paints	Paints using cellulose-derived water soluble polymers
13	Cosmetics and personal-care products	Biobased products in toothpaste, lotions, and shampoos
14	Landscaping products	Decorative bark, railroad ties
15	New fibers, fillers, yarn, and insulation	Cotton fibers and rayon (cellulose derivative) textiles. New insulation using cotton processing trash and recycled textile fibers, filler for auto fenders, and panels for vehicle liners
16	Pharmaceuticals and veterinary products	Taxol for cancer treatment

Examples of Bioenergy and Biobased Products Facilities



Key Agencies

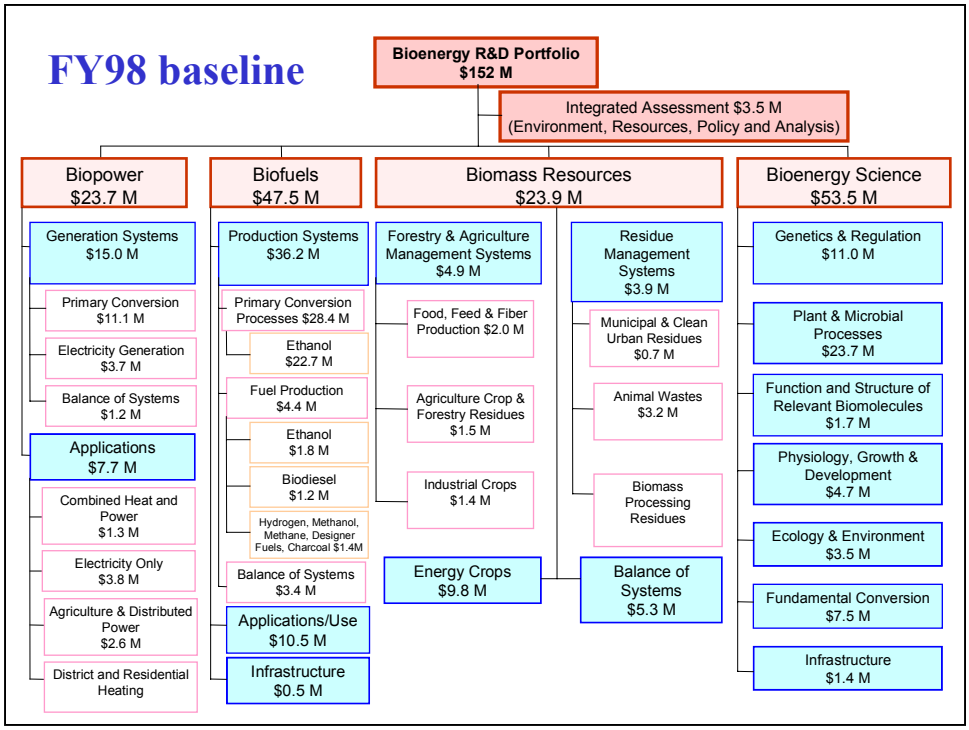
From Inventory of FY98
R&D Activities: $253 Mi
DOE + USDA = $228 Mi
DOE = $108 Mi
USDA = $120 Mi



Portfolio Analysis Methodology

- Across a systematic classification of technical lines -- Taxonomy
- Across U.S. government-programs using the Research and Development in the United States (RaDiUS) database and agencies' program information
- Across Agencies' specific databases such as Current Research Information Systems of the USDA (delay of 2 years for grant info)

Conducted by NREL and ORNL staff over a period of four months

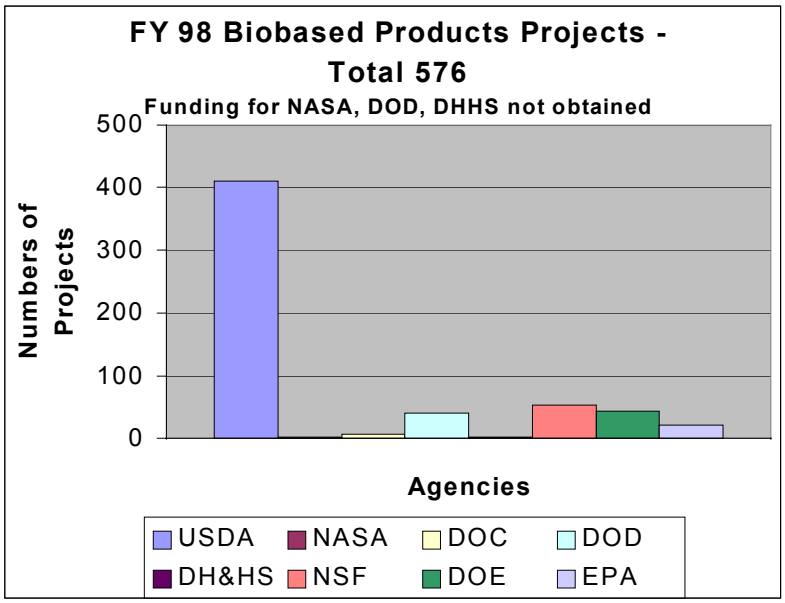


FY 98 Bioenergy Direct Projects by Phase of Research (Estimated) $152 Million (61% DOE, 32% USDA)

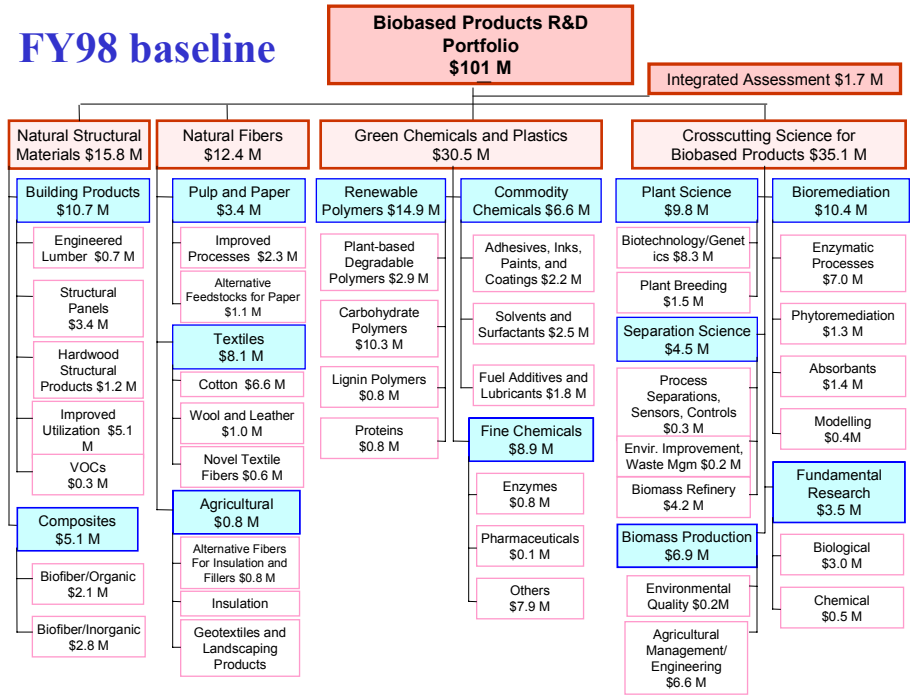
Phase	Estimated # Projects
Basic Research	400
Exploratory Projects	380
Development Projects	30
Pilot Developments in Industry	12
Integrated Assessments	28
Total # Projects	850

FY98 Funding Summary for Selected Technologies/Products					
		Funding in Million $			
	Total	DOE	USDA	NSF	EPA
Ethanol	$33.7	$25.6	$6.4	$1.3	$0.4
Hydrogen	$2.6	$2.5			$0.1
Biodiesel	$4.9	$3.1	$1.3	$0.4	
Pretreatment	$6.7	$3.0	$1.5	$2.2	
Enzymatic Hydrolysis	$7.1	$3.0	$2.4	$1.3	$0.4
Gasification	$8.2	$8.2		$0.0	
Cofiring	$4.5	$4.3	$0.2		

FY Baseline data can be sorted by different technology grouping areas



FY98 baseline



Strategic Plan
Biorefinery Examples

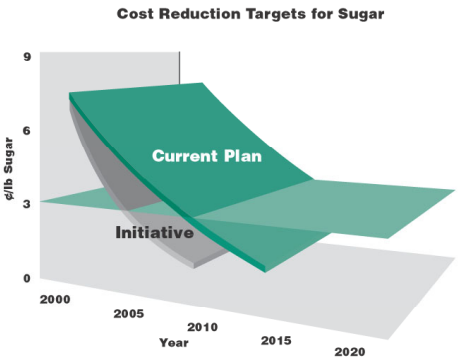


Figure 3. Although R&D helped reduce costs of sugars from lignocellulosic biomass by a factor of six since 1980, further reduction in cost is needed for widespread use of sugars for fuels, chemicals, materials, and other products.

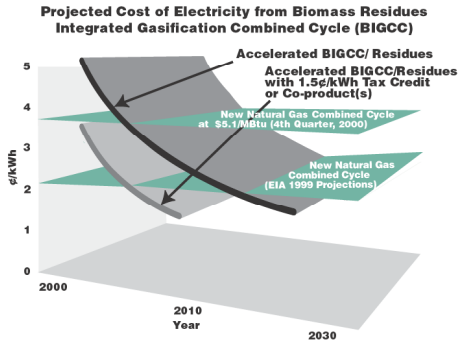


Figure 4. Accelerated R&D can reduce the cost of electricity from biomass residues compared to today's lowest electricity cost from new natural gas using combined-cycle. Biomass electricity costs could be reduced even further and become competitive earlier if coproducts are developed quickly. Alternatively, costs can be reduced earlier if production tax credits are maintained over a sufficiently long period of time to justify private-sector investment, new technology development, and adoption. (EIA is the Energy Information Administration) (Note: costs assume municipal financing).

Critical technologies need cost reduction to increase market penetration and make multiple products

New Products Needed and Cost Reduction in Crops, Short Rotation Trees, and Infrastructure for Residue Collection

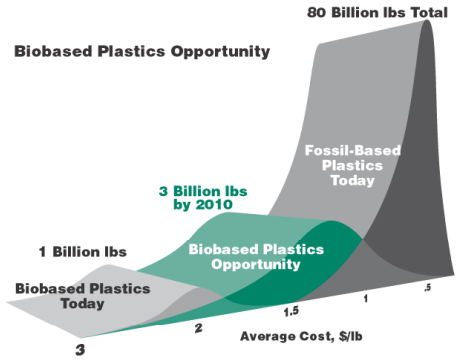


Figure 5. Pictorial example of today's costs and volumes (distribution) of biobased and fossil-derived plastics. In the future, these distributions could change markedly, as shown in the center distribution curve. Biobased products could generate 3 billion pounds or more of products covering a wide range of costs and volumes by 2010 and significantly offset petroleum use.

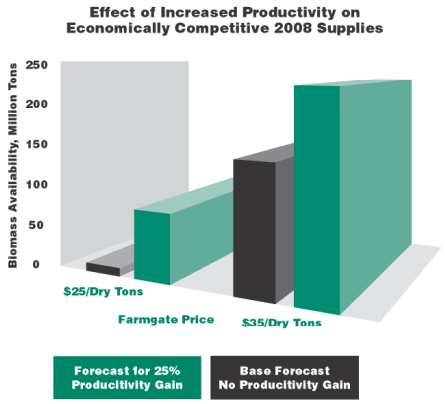


Figure 6. Plant science research is required to increase productivity and reduce uncertainty of biomass crop supplies. Productivity increases could lead to more supplies of energy crops that are economically competitive by 2008

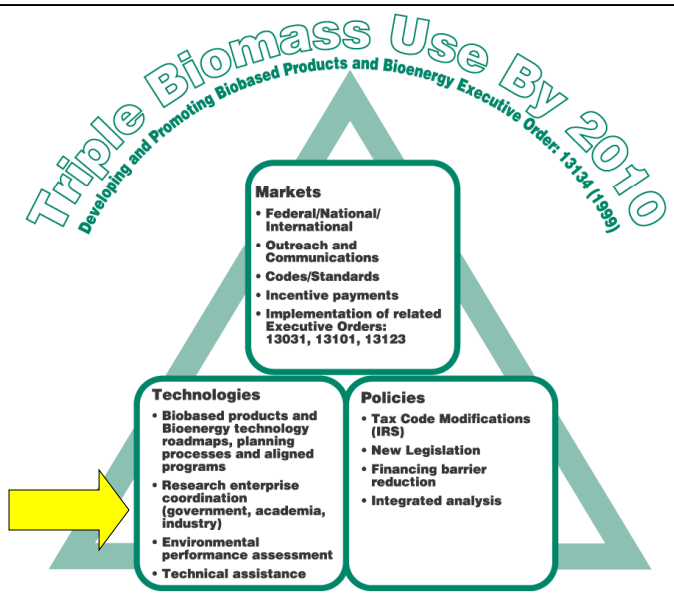


Figure 9. Examples of actions to triple biomass use by 2010. These include research, development, and demonstration in technology and product development. Among actions are coordinated policy modifications to create government markets and facilitate commercial market development. Also included are the continuing implementation of related Executive Orders (13031, Federal Alternative Fueled Vehicle Leadership; 13101, Greening the Government through Waste Prevention, Recycling, and Federal Acquisition; and 13123, Greening the Government through Efficient Energy Management).

Research Enterprise Coordination
Coordinated by DOE National Bioenergy Center

- Strategic Partnerships Meeting - April
  - Federal laboratories (both GOGO and GOCO)
  - Federal program managers
  - Opportunities for partnering and coordination
  - Identification/validation of key technical/scientific challenges
  - Outcome - Compiled Capabilities of Federal Laboratories on the National Biobased Products and Bioenergy Coordination Office Web
- Follow up meetings
  - Academia, Federal, Private sector at the 5th Biomass Conference of the Americas, Orlando, Florida, September 17-21, 2001

Special Enterprise Coordination Session

Research Enterprise Coordination Pathways Being Explored

- Universities led by Iowa State University will be meeting to coordinate their activities at national laboratory sites (proposed activity approved by the Biomass R&D Board but not yet funded).
- **Regional consortium formed** -- Iowa State University, Ames Lab, ANL, Michigan State University, University of Illinois, Purdue University, Peoria USDA Lab -- Midwest Consortium for Sustainable Bio-based Products and Bioenergy.
  - The consortium was formed to research and develop new environmentally friendly and renewable chemical products such as plastics made from soybeans, and fuel made from corn.

Examples of Actions to Reach the National Goal

To assess and enable the country to accrue all the benefits from the increased use of biobased products and bioenergy, combined actions by several agencies are necessary. Table 2 shows the agencies involved in these actions

TABLE 2 Agencies Participating, in the Implementation of the National Goals

Goals and Actions	DOE	USDA	EPA	NSF	DOC/NIST	DOI	TREASURY	OSTP	FEE	GSA	TVA
Technology Development Goals											
1. Technology Cost Reduction	X	X	X		X			X			X
2. Critical Technology Demonstration	X	X			X			X	X		
3. Environmental/Ecosystem Impact	X	X	X		X	X		X	X		X
4. Innovative Science & Technology	X	X	X	X	X			X			X
Public Policy and Markets Goals											
5. Coordinated Policies	X	X	X				X	X	X		X
6. Increase Federal Market Pull	X	X	X		X		X	X	X	X	X
7. Increase Commercial Market Pull	X	X	X		X		X	X	X		X
Examples of Actions											
Tax Code Modifications	X	X	X				X	X	X		
New Legislation	X	X	X				X	X			
Financing Barrier Reduction	X	X	X		X		X	X	X		X
Federal Markets	X	X	X			X		X	X	X	
National/International Markets	X	X	X		X			X	X		
Outreach and Communications	X	X	X			X		X	X		X
Codes/Standards	X	X	X		X						
Incentive Payments	X	X					X	X			X
Related Executive Orders: 13101		X	X						X		
Related Executive Orders: 13031, 13123	X		X						X		

Acronyms

DOE	U.S. Department of Energy
USDA	U.S. Department of Agriculture
EPA	Environmental Protection Agency
NSF	National Science Foundation
DOC	Department of Commerce
NIST	National Institute of Standards and Technologies
DOI	Department of Interior
TREASURY	Department of the Treasury
OSTP	Office of Science and Technology Policy
FEE	Federal Environmental Executive
GSA	General Services Administration
TVA	Tennessee Valley Authority

Executive Orders

13031	Federal Alternative Fueled Vehicle Leadership
13101	Greening the Government through Waste Prevention, Recycling and Federal Acquisition
13123	Greening the Government through Energy Efficiency Management

Strategic Plan "*Fostering the Bioeconomic Revolution in Biobased Products and Bioenergy.*"

GOAL 1: Reduce costs of technologies by two- to ten-fold for integrated supply, conversion, manufacturing and application systems for biobased products and bioenergy by 2010.

- Implement and strengthen coordinated federal R&D programs and justify integrated funding requests across federal departments and agencies.
- Conduct competitive solicitations on key R&D issues, and ensure that solicitations reach a "critical RD&D mass" to achieve the goal.
- Develop resource-efficient, environmentally sound, high productivity feedstock production systems.

GOAL 2: Demonstrate critical integrated biobased products and bioenergy systems for fuels, heat, power, chemicals and materials between 2002-2008 so they may contribute to the tripling goal by 2010.

- Identify the scientific and technological resources that will be needed. Fully utilize relevant existing facilities (federal, state, academia and private).
- Craft public-private sector partnerships to demonstrate promising technologies.
- Leverage private investments to demonstrate promising technologies.

GOAL 3: Monitor and evaluate the environmental and ecosystem impacts of biobased products and bioenergy systems at all stages of development.

- Research on areas that have substantial potential to replace fossil-based fuels.
- Establish specific review committees and open processes to oversee environmental monitoring and evaluation.
- Conduct ongoing life-cycle analyses to evaluate integrated systems and determine areas for environmental improvement.
- Utilize information technologies to assemble, analyze, and disseminate information on environmental impacts of bioenergy and biobased products.

GOAL 4: Foster innovation-driven science of biomass feedstocks, biobased products, and bioenergy and quickly incorporate these scientific results in the relevant technology development activities.

- Strengthen and integrate basic scientific research and grant programs.
- Enhance human resource development.
- Strengthen partnerships between the public and private sectors.
- Evaluate biannually the federal, state, and private sector biobased products and bioenergy R&D portfolio to identify gaps in frontier science and technology.
- Identify opportunities for technology transfer from other functional genomics and metabolic engineering R&D, such as on human systems.
- Identify R&D issues that would greatly benefit from dedicated Centers of Excellence attention and, where appropriate, extend existing or develop new programs that address key challenge areas.

Strategic Plan "*Fostering the Bioeconomic Revolution in Biobased Products and Bioenergy.*"

GOAL 5: Coordinate policies to achieve early market adoption and create demand.

- Identify in detail the principal barriers and systematically develop policy mechanisms to overcome them.
- Identify existing federal and state authorities that can be used to facilitate early adoption.
- Link environmental benefits to public policy development.
- Encourage standards and labels. Work with the private sector and non-governmental organizations to identify the appropriate role of government in this effort.
- Undertake educational and outreach programs to encourage consumer preference.

GOAL 6: Increase government market pull so that by 2010 bioenergy supplies five percent of the federal energy purchased or produced and biobased products supply ten percent of the relevant federal purchases.

- Inform consumers and government employees about the benefits of biobased products and bioenergy so they will support the federal market pull effort.
- Provide justification for legislative action to facilitate the purchase of biobased products and bioenergy.
- Use targeted demonstration programs that collect data over time and quantify benefits and costs of use in federal facilities.

GOAL 7: Facilitate development of commercial market pull by 2010 to triple biobased products and bioenergy use in emerging industries and to increase by 30% lumber, pulp and paper products use from mature industries.

Strategic Plan "*Fostering the Bioeconomic Revolution in Biobased Products and Bioenergy*"

Ten Strategies common to all goals

1. Use public-private partnerships to leverage tax-year dollars to the maximum extent feasible.
2. Utilize strategic planning processes with stakeholders.
3. Ensure relevance of targeted federal investments with the assistance of the Biomass Research and Development Technical Advisory Committee.
4. Use external peer review to oversee and provide independent validation of proposed plans.
5. Establish appropriate criteria for terminating unsuccessful projects and develop sunset criteria for phaseout of incentives.
6. Employ competition whenever possible.
7. Pursue multiple objectives wherever possible.
8. Take advantage of technology and information transfer mechanisms set up by agencies to increase coordination.
9. Develop education initiatives to broadly inform consumers and the general public of the benefits of increased use of biobased industrial products.
10. Establish a mechanism to measure progress via appropriate metrics tailored for each area.

Technology Development Milestones Examples

GOAL 1

- *By 2010, halve the year 2000 cost of producing sugars from lignocellulosic biomass.*
- *By 2010, develop the technologies for cost-competitive biomass gasification platforms for both power and biorefinery co-products.*
- *By 2010, develop 250 new biobased products for commercialization. This number includes at least 20 high-energy use impact biobased products.*

GOAL 2

- *By 2002, complete an inventory of public resources and facilities.*
- *By 2002, demonstrate an integrated, commercial-scale facility for multiple products. One example is to use lignocellulosic biomass to produce sugars, ethanol, and power.*
- *By 2008, demonstrate integrated gasification technologies for producing power and multiple products, including hydrogen. Implement gasification technology in three plants of the pulp and paper industry by 2010.*
- *Between 2002-2008, demonstrate rural-based processing plants for biobased products, including plants owned by farmers or farm cooperatives. Examples include composites, building materials, plastics from crop residues, and small-scale production of power using integrated gasification technology with advanced power sources.*

Technology Development Examples of Milestones

GOAL 3

- *By 2002, review environmental and ecosystem monitoring by the federal, state, and local governments agricultural forestry, and environmental agencies and private sector and non-governmental organizations.*
- *By 2002, develop tools and information resources that will facilitate identification of those biobased products and bioenergy technologies that can provide economic, agricultural, energy, and environmental benefits simultaneously and produce a plan to accelerate their development. This will help farmers identify more profitable crops and assist them in developing farm cooperatives to supply biobased products and bioenergy to new markets.*
- *On an ongoing basis, identify and implement opportunities to leverage these monitoring efforts and expertise, supplementing them as needed, to support life-cycle environmental and ecosystem monitoring of biobased product and bioenergy systems.*
- *By 2002, establish a national program initiative to promote understanding of the role of bioproducts and bioenergy in enhancing environmental sustainability in USDA's Cooperative Extension Service, in state cooperative extension service programs, and in USDA's NRCS.*
- *By 2003, evaluate current and prospective life-cycle environmental costs and benefits of key biobased products and bioenergy important to achieve the tripling goal and compare them with fossil-fuel based alternatives.*

GOAL 4

- *By 2010, develop complete functional genomics for five target feedstocks. Use thee capabilities, for instance, to double overall lignocellulosic productivity at significantly reduced inputs.*
- *By 2005, develop complete functional genomics for 10 target biocatalysts and develop associated metabolic engineering by 2010 to triple reaction rates and significantly reduce end-product inhibition.*
- *On an ongoing basis, create advanced tools for information and computing technologies including those that encourage collaborative learning and intelligence. Use them to develop functional genomics and metabolic engineering science and technology, and to provide specific information on targeted plants and organisms.*

Market and Public Policy Examples of Milestones

GOAL 5

- *By 2002, develop a coordinated proposal for modifying the tax code and other policies to encourage private-sector investments in integrated biobased products and bioenergy development and deployment and to overcome the barriers limiting development of this sector.*
- *By 2002, develop mechanisms to assist the buy-down of initial capital costs of new technologies, and mitigate risks in deploying first-of-a-kind technologies.*
- *By 2002, develop mechanisms to assist farmers nd farmer cooperative to gain economic benefits from biobsed products and bioenergy.*
- *By 2003, announce labeling programs to facilitate marketing of products and technologies. These programs will be defined with the private sector.*
- *By 2005, have federal incentives such as tax credits and appropriate tax-credit programs in place and funded. Have appropriate parallel incentive mechanisms for public power companies.*
- *By 2005, complete performance testing on those biobased products and bioenergy of primary importance to achieving the tripling goal.*

Market and Public Policy Examples of Milestones

GOAL 6

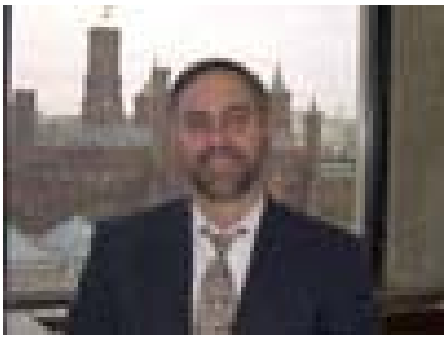
- *By 2002, publish a USDA-approved biobased products list for federal procurement.*
- *By 2002, develop legislative language and facilitate enactment of legislation to modify Section 6002 of the Resource Conservation and Recovery Act to require federal procurement officials to purchase certain levels of biobased products and bioenergy.*
- *By 2010, bioenergy accounts for 5 percent of federal energy facilities and biobased products penetrate 10 percent of federal purchases of relevant products.*
- *By 2010, work with all states to enact legislation that increases state purchases of biobased products and bioenergy.*

GOAL 7

- *By 2002, work with educators to develop K-12 classroom materials that focus on the science-based environmental sustainability attributes of biobased products and bioenergy.*
- *By 2002, establish 25 centers of excellence at colleges and universities to develop college-level classroom materials and outreach education materials focused on the role of biobased products and bioenergy in enhancing environmental sustainability.*
- *By 2005, implement cofiring in 5 percent of pulverized coal boilers. Joint DOE and EPA action with public and private electricity generators will achieve this milestone.*
- *By 2010, triple biofuels production through cooperative USDA, DOE, and EPA actions with industry.*

National Biobased Products and Bioenergy Coordination Office

Doug Kaempf - DOE Co-Chair
Ron Buckhalt - USDA Co-Chair



Ron Buckhalt - USDA Co-Chair **Doug Kaempf - DOE Co-Chair**

Progress Report April 2001

Establish the Vision	✓	Designate DOE and USDA Points of Contact	✓
Develop Roadmaps	✦	Establish Biomass R&D Board	✓
Develop Strategic Plan	✓	Establish a Technical Advisory Committee	✓
Report to Congress	✦	Carry Out Education and Outreach	$'01
Expand and Maintain Effective Partnerships	✦ ✓	Promote Advanced Technologies	$'01
National Bioenergy Center	✓		

✓ = Action Completed ✦ = Efforts Underway $'01 = Funding Awarded

Biomass Research and Development Technical Advisory Committee

CO-CHAIR:

Jack Huttner – Genencor International, Inc.

CO-CHAIR:

Glenn English – National Rural Electric Cooperative Association

Larry Bean – ***Governors' Ethanol Coalition***

Robert Boeding – ***National Corn Growers Association***

Dale Bryck – ***Natural Resources Defense Council***

Robert Dorsch – ***Dupont***

Douglas Durante – ***Clean Fuels Development Coalition***

Loyd Forrest – ***TSS Consultants***

Carolyn Fritz – ***The Dow Chemical Company***

Stephen Gatto – ***BC International***

William Guyker – ***Allegheny Power Systems***

Ronald Heck – ***Farm Corporation & American Soybean Association***

Walter Hill – ***Tuskegee University***

Roland Hwang – ***Union of Concerned Scientists***

Terri Jaffoni – ***Cargill, Inc.***

Michael Ladisch – ***Purdue University***

David Morris – ***Institute for Local Self Reliance***

William Nicholson – ***Potlach Corporation***

Edan Prabhu – ***Reflective Energies***

Roger Rivera – ***National Hispanic Environmental Council***

Jefferson Seabright – ***Texaco***

Philip Shane – ***Illinois Corn Growers Association***

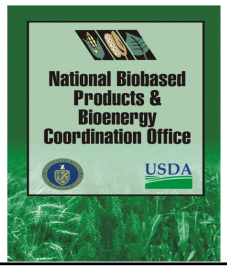
Larry Walker – ***Cornell University***

John Wooten – ***Peabody Group***

Holly YoungBear-Tibbets – ***College of the Menomiee Nation***

USDA and DOE Coordination

- **DOE & USDA Agency working groups established August, 2000**
- **National Coordination Office established February 2000**
- **Biomass R&D Board established November 2000**
- **Advisory Committee established November 2000**
- **Report to the President – Delivered in October 2000**
- **Strategic Plan – Completed March 2001**
- **Initial Report to Congress - underway**



Solicitations

- **CSREES's Initiative for Future Agriculture and Food Systems (IFAFS)**
  - 13.4 Million
  - Exploration of biobased products and bioenergy in interactive systems-based approaches.
- **USDA 25 Million in Grants for the Development of Agricultural Producer-Owned Processing Businesses**
  - The grant announced on March 6, 2001, supports independent agricultural commodity producers to process raw materials into marketable goods.
- **Biomass Research and Development Advance Biomass Power Generation Technologies (DE-PS26-01NT41130)**
  - 1 Million
  - Support improved gasification-based technologies for power, heat and co-production.
- **Power Plant Improvement Initiative, Financial Assistance, Solicitation (DE-PS26-01NT41104**
  - 95 Million
  - Research of alternative fuels in cofiring and gasification to increase the efficiency of current operating power plants.

Solicitations

- **Agriculture Industry of the Future (DE-PS07-01ID14039)**
  - 1.5 Million
  - Research, development and demonstration of technologies in plant sciences, production, processing, and utilization.
- **Biomass and Alternate Methane Fuel (BAMF) Technology Specific Super Energy Savings Performance Contract (DE-RP26-00NT40626)**
  - 4 Million
  - Biomass and alternate methane fuels utilization in federally owned facilities.
- **Innovative Technologies for Conversion of Biomass to Fuels and Chemicals**
  - 2 Million
  - Solicitation will award $2M to multiple contracts for innovative technologies for the conversion of biomass to fuels and chemicals, particularly in the areas of pretreatment and hydrolysis to sugars.
- **Biomass Research and Development Initiative/Crosscutting Technologies for Conversion of Biomass to Fuels and Chemicals (DE-PS36-01GO90000)**
  - 2 million
  - Conversion of biomass into fuels and chemicals.